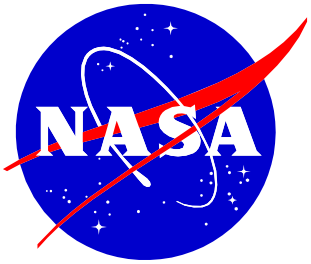
GAMMA-RAY LARGE AREA SPACE TELESCOPE (GLAST) PROJECT

CONTINUOUS RISK MANAGEMENT PLAN

August 5, 2003



GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

GLAST PROJECT

CONTINUOUS RISK MANAGEMENT

PLAN

August 5, 2003

GODDARD SPACE FLIGHT CENTER

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GLAST PROJECT

CONTINUOUS RISK MANAGEMENT PLAN

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CHANGE RECORD PAGE

DOCUMENT TITLE: GLAST Project Continuous Risk Management Plan

DOCUMENT DATE: August 5, 2003

ISSUE	DATE	PAGES AFFECTED	DESCRIPTION
Original	08/05/03	All	CCR# 433-0058 R2.
CH 01	07/12/04	iii, 1-2, 2-1, 3-1,3-2, 3-6, 4-2, 4-4, 7-2, B5, and B6	CCR 433-0219R1
CH-02	9/10/04	iii, v, 7-3 and 7-4	CCR 433-0262

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1.0 Introduction

The Gamma-ray Large Area Space Telescope (GLAST) is an international and multi-agency space mission that will study the cosmos in the energy range 10 keV - 300 GeV. Several successful exploratory missions in gamma-ray astronomy led to the Energetic Gamma Ray Experiment Telescope (EGRET) instrument on the Compton Gamma Ray Observatory (CGRO). Launched in 1991, EGRET made the first complete survey of the sky in the 30 MeV - 10 GeV range. EGRET showed the high-energy gamma-ray sky to be surprisingly dynamic and diverse, with sources ranging from the sun and moon to massive black holes at large redshifts. Most of the gamma-ray sources detected by EGRET remain unidentified. In light of the discoveries with EGRET, the great potential of the next generation gamma-ray telescope can be appreciated.

The mission will start with a one-year all-sky survey of gamma-ray sources, after which, a scheduled observing plan will be derived for guest observers who can apply for observation time through a formal selection process. Scheduled observations will be interrupted at times for special "targets of opportunity", i.e., spontaneous events that occur for which it would be in the best interest of the science to repoint the spacecraft immediately to obtain gamma-ray data of these targets. Exploring these high-energy objects and events with the advanced technologies of GLAST could give us an entirely new understanding of our Universe and reveal unanticipated phenomena, particularly in fundamental physics. This knowledge could eventually be applied to improve current technologies or give rise to altogether new ones.

The NASA GLAST Project, Continuous Risk Management (CRM) Plan defines the process and implementation for conducting CRM throughout the operational phase of the Space Science Enterprise missions assigned to the GLAST Project. Implementation of this plan establishes a continuous risk process (identify, analyze, plan, track, and control) that is consistent for all mission elements under GLAST Project management and ensures that communications and documentation are maintained across the project. Guidelines for this process are provided in “NPG 7120.5, NASA Program and Project Management Processes and Requirements Document”.

This CRM Plan is intended to compliment overall GLAST Project Management and make CRM an integral part of project management. Implementation of this plan solicits inputs from everyone in the project, individuals, group leaders, and managers with the Project Manager giving final approval for implementation of this plan. This plan will be reviewed at least annually and updated as required.

1.1 Purpose

The purpose of this document is to describe the Continuous Risk Management Plan tailored for the GLAST Project. The objective is to implement formal CRM for the operational life of the GLAST Project. The plan includes brief descriptions of the CRM processes to be used in carrying out this effort. CRM will assist the project in performing informed decision-making, optimizing resource allocation and use, and coordinating trade studies against cost, schedule, and performance goals.

1.2 Scope

This document describes a formal process for utilizing CRM throughout the entire operational life of the GLAST Project. CRM applies to NASA GSFC activities, as performed by both civil servants and contractors (Ref. Section 2.2) supporting GLAST Project operations, including spacecraft, instrument, ground system, and all disciplines supporting the project. In addition, the objective of CRM is to forecast and manage risks before they become problems. To the extent possible, GLAST Project will utilize lessons learned from other operational missions in carrying out this CRM Plan. Upon approval of the GLAST Project Manager, the GLAST Risk Management Plan will become a controlled document. Revisions/additions to this document will be made in accordance with the approved GLAST CM processes. The GLAST Project Plan is the governing document for GLAST Risk Management Plan. CH-01

1.3 Descope Options

The GLAST Project descope methodology is discussed in the GLAST Mission Descope Plan (433-PLAN-0013). Descope options are proposed and documented in agreements between the GLAST Project Office and the appropriate HQ Code S personnel. It is our belief that successful implementation of risk management and risk mitigation techniques will negate the need to exercise our pre-defined descope options.

1.4 Document Organization

This document is organized into five major sections.

Section 1 is an introduction and overview of this document.

Section 2 lists parent, applicable and reference documentation.

Section 3 provides an overview of GLAST Project continuous risk management process.

Section 4 describes the risk identification, analysis, and planning process being used.

Section 5 describes the tracking, control, and communication necessary for CRM.

Section 6 provides a summary of our FTA and FMEA approach, along with tools utilized for the implementation of risk management on the GLAST Project.

Section 7 describes the tools used to implement CRM on the GLAST Project.

Appendix A contains a list of acronyms used in this document.

Appendix B includes documentation figure for the Risk Information Database Form including process and instructions for filling it out. Also, the GLAST Score Card is depicted here.

2.0 Related Documentation

This section lists additional, related documents. Section 2.1 lists the parent document that establishes the criteria and technical basis for this document. Section 2.2 lists the applicable document; this document is in conformance with the requirements and contents of this document. Section 2.3 lists recommended reference documents for informational purposes.

2.1 Parent Document

433-PLAN-0001, GLAST Project Plan, dated November 2003 CH-01

2.2 Applicable Documents

NPG 7120.5, NASA Program and Project Management Processes and Requirements Document.

The Mission Assurance Requirements (MAR) Document for the LAT (433-MAR-0001) ; GBM (433-MAR-0002); S/C (433-MAR-0003); and GLAST Ground System (433-MAR-0004) are prepared by the GLAST Project Code 300 representative. These documents define and describe the flow down requirements to the GLAST Project sub-contractors.

The latest version of GSFC governing documents listed below, as found on the http://gdms.gsfc.nasa.gov/gdms/plsql/menu_guest are applicable to the GLAST Project.

GPG 1060.1

GPG 1410.1

GPG 1440.7

GPG 1710.1

GPG 7120.4

NPG 8000.4

2.3 Reference Documents

433-PLAN-0001 GLAST Project Plan, Dated November 2003 CH-01

Carnegie Mellon University, Continuous Risk Management Guidebook, Copyright 1996

GSFC SMO, Course Materials and Workshop Materials, Dated July 2001

3.0 Continuous Risk Management Overview

This section provides an overview of the CRM process and its relation to the GLAST Project Management, including primary activities, process steps, terms, and definitions. Details of the CRM process along with actions, tasks, and tools specific to the GLAST Project, are provided in subsequent sections of this plan.

There are six primary activities of the CRM process:

Risk Identification: continuous efforts to capture, acknowledge, and document risks as they are found.

Risk Analysis: an evaluation of all identified risks to estimate the likelihood of occurrence, severity of consequence, timeframe when mitigation action/s must be initiated, classification into sets of related risks, and priority ranking. CH-01

Risk Planning: establishes actions, plans, and approaches for addressing risks and assigns responsibilities and schedules for completion. Metrics for determining the risk status is also defined during this step.

Risk Tracking: an activity to capture, compile, and report risk attributes and metrics which determine whether or not risks are being mitigated effectively and risk mitigation plans are being performed correctly.

Risk Controlling: an activity that utilizes the status and tracking information to make a decision about a risk or risk mitigation effort. A risk may be closed or watched, a mitigation action may be re-planned, or a contingency plan may be invoked. Decisions on the appropriate resources needed are also determined during this activity.

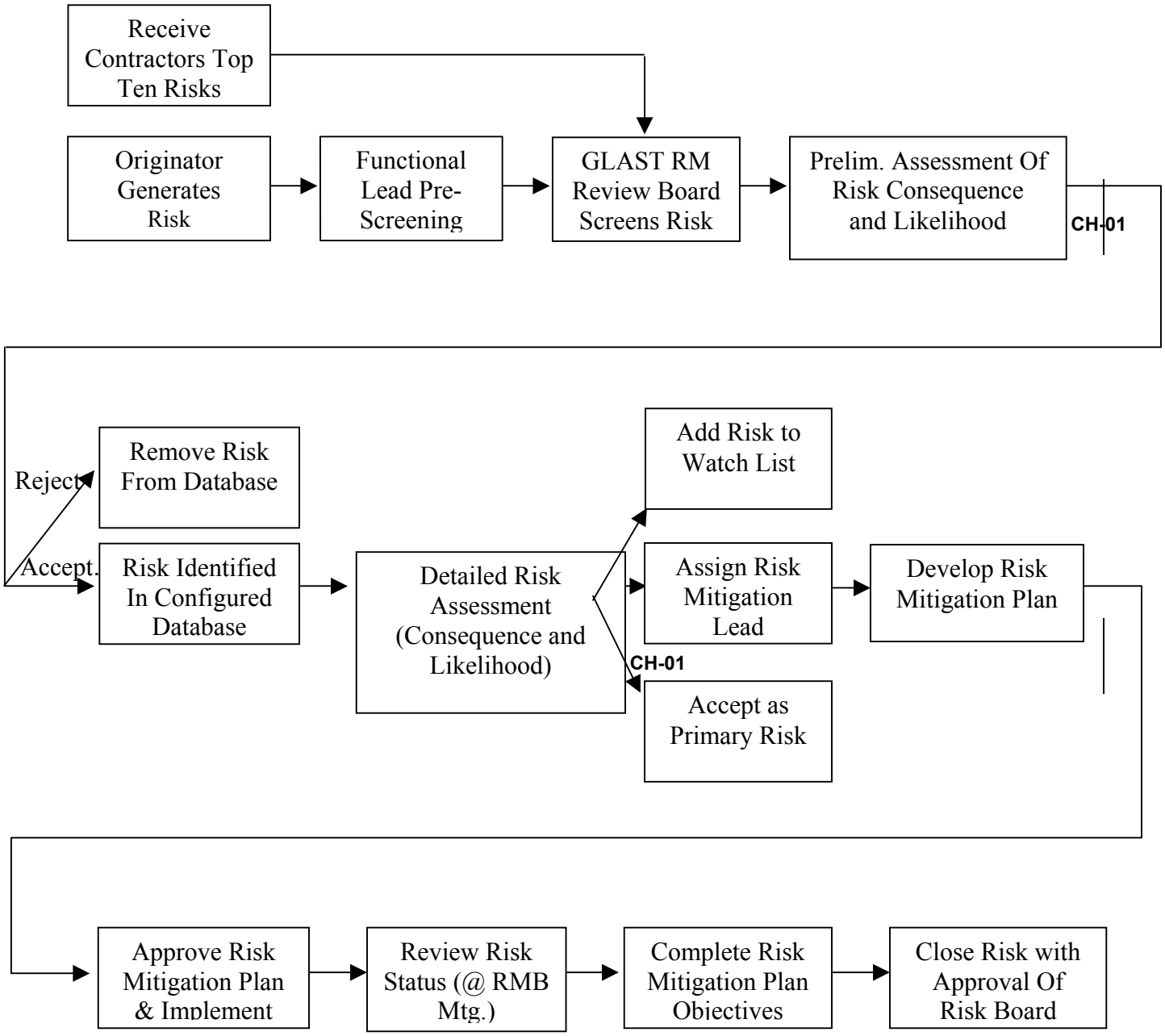
Risk Communicating and Documenting: an overt action to communicate and document the risk at all steps of the CRM process. This can be in the form of an action item log, Risk Information Database, risk database, mitigation plan, status report, tracking log, and/or meeting decision.

CRM is carried out during day to day activities of GLAST Project personnel, as well as during key meetings. Nominally, for the GLAST Project, only those risks with a red or yellow exposure grade (see section 4) will have project resources/monies expended for mitigation. However, all other risks will be watched or accepted and with the Project Managers approval project resources/monies can be extended for mitigation activities. Watched risks have their attributes examined and reported on a monthly basis. It is also understood that not all risks to a project are identified; it is the intent of CRM to provide the means to handle identified risks. CH-01

3.1 Risk Management Process and Data Flow

Figure 3-1 illustrates the CRM process flow for the GLAST Project.

Figure 3-1. CRM Process Flow for the GLAST Project



* See Section 4.3 Primary Risks

3.2 GLAST Project Organization

Figure 3-2. Depicts the organization as defined in the GLAST Project Management Plan. It is repeated here for convenience. The diagram illustrates the structure of the project team along with the organizational role of each team member. All members of the GLAST team will play a role in the implementation of the GLAST RM Plan. Training will be required for all senior GLAST Project personnel.

3.3 GLAST Project Functional Assignments

Figure 3-3 depicts the responsibilities of all project personnel as individuals, Sub-Systems Managers, and GLAST Project Manager for managing risk within the GLAST Project. The diagram identifies the personnel responsible for performing each specific CRM task. A dotted line splitting any boxes shown in Figure 3-3 represents a shared responsibility for activities within the boxes. Tables 3-1 and 3-2 further defines these responsibilities and paths of communication.

The GLAST Project Manager will be responsible for ensuring that the GLAST Risk Management guidelines are fully implemented.

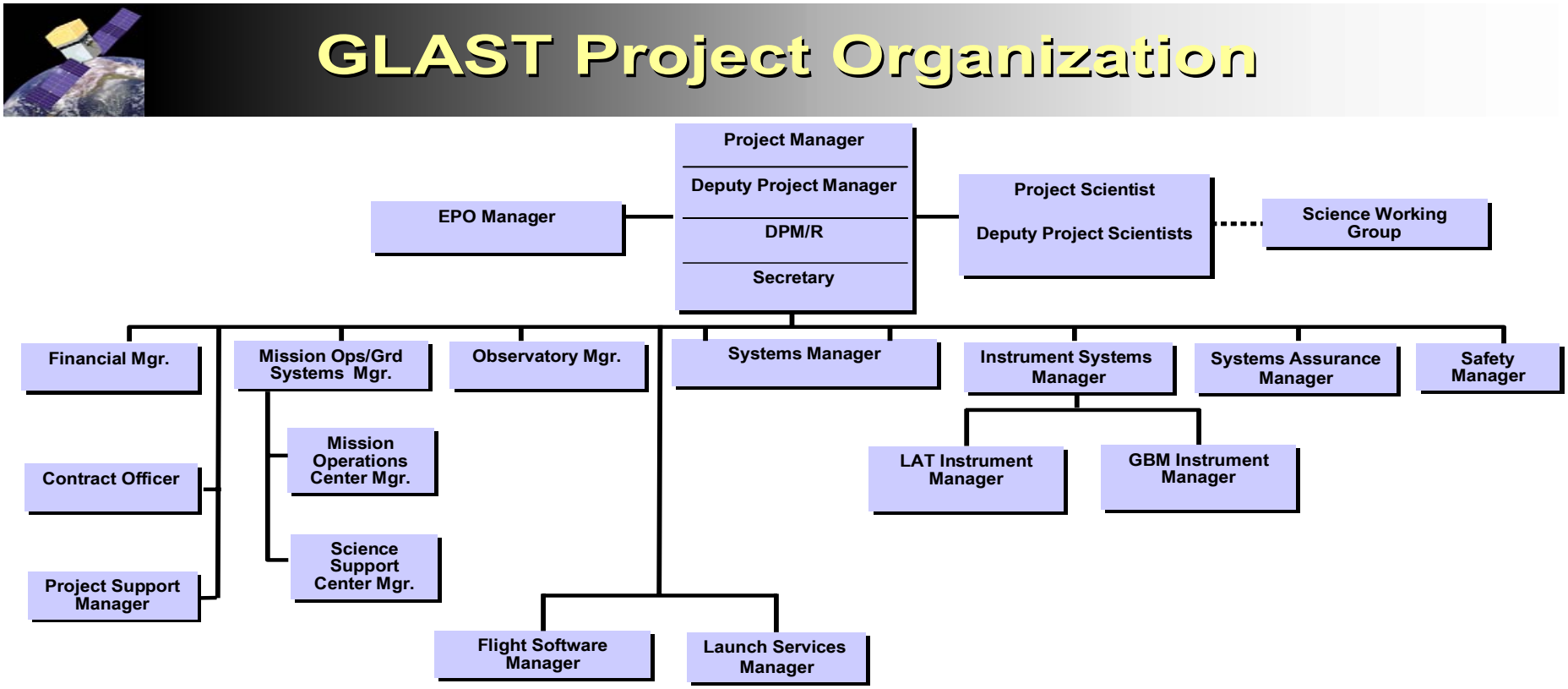


Figure 3-2. GLAST Project Organization

GLAST Project Risk Management Functional Assignments

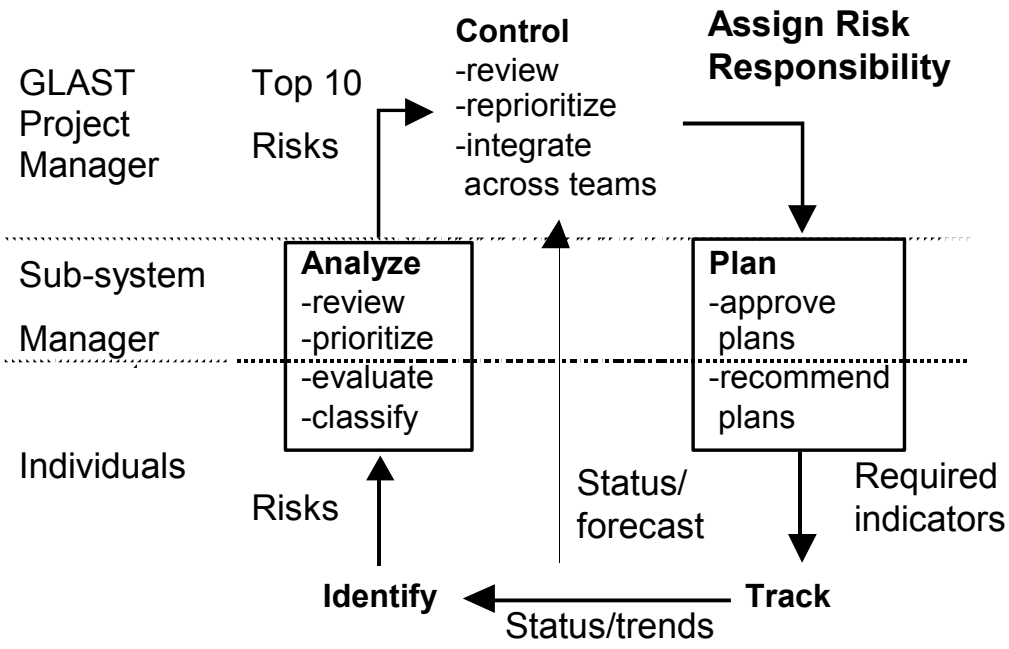


Figure 3-3. GLAST Project Responsibilities

Table 3-1. GLAST Project Responsibilities

Who	Responsibilities	
Individuals	System Manager, Sub-System Managers, PI's, Engineers, Scientists, Project Manager, Contractors, and Customers • identify new risks • estimate likelihood, consequence, and time frame • classify risks • recommend approach and actions • track risks and mitigation plans (acquire, compile, and report) • Assist in risk prioritizing	CH-01
Risk Mitigation Leads	• Develop and implement (approved) Risk Mitigation Plans	
Systems/Line Managers (Members of GLAST RMB)	• integrate risk information from all individuals • ensure accuracy of likelihood /consequence/timeframe estimates and the classification • review recommendations on mitigation approach and action • reprioritize all risks to determine risk grading • assign or change responsibility for risks and mitigation plans • report their risk grading recommendations to the Project Manager • implement control decisions for risks • risk assignee • build action plans (determine approach, define scope, & actions) • collect and report general risk measures/metrics • coordinate communications with GLAST Project Manager • review and evaluate contractor Risk Lists	CH-01
GLAST Risk Manager	• administer the GLAST Risk management process • conduct risk management review meeting • assure adherence to GSFC/GLAST Project RM guidelines	
GLAST Project Manager (Chairperson of GLAST RMB)	• authorize expenditures of resources for mitigation • integrate risk information from all Sub-Systems Managers • reprioritize all risks to determine the red graded project risks • make control decisions (analyze, decide, execute) for red graded and Primary project risks • assign or change responsibility for risks and mitigation plans within the project • coordinate communication with Sr. Managers and external customers • review general risk measures/metrics with SAM during each quarter to evaluate effectiveness of risk management	

Table 3-2 provides the criteria for communicating and documenting risk information.

Table 3-2. GLAST Project Risk Information

Communication Path	Risk to be Communicated/Documented
From Individuals to Systems Manager	• Any risk that impacts performance of experiment • Any risk that impacts >$50K of budget • Any risk that exceeds schedule milestones • Any risk that needs to be transferred to another team
From Systems Manager to GLAST Project Manager GLAST Project Manager to Systems Manager	• Red/Yellow graded risks of the IPT • Red/Yellow graded Risk Trends and Status • Mitigation activity status • Disposition of Primary Risks
GLAST Project Manager to Senior Management Senior Management to GLAST Project Manager	• Red graded and Primary risks in the project • Any risk that impacts mission success • Any risk that impacts the technical and scientific aspects of the GLAST Project • Any risk that causes major slips of schedule milestones • Any risk that cause the project budget to be exceeded by more than 10% • Any risk that negatively impacts NASA's reputation • Risk Status • Maintain risk database
GLAST Contractor Group	• Follow GLAST RM guidelines • Submit Top Ten risk list to COTR on a quarterly basis • Communicate identification of risks to GLAST Project office in a timely manner

4.0 Risk Identification, Analysis, and Planning

Performing risk identification, analysis, and planning for the GLAST Project are the first three phases of CRM. These steps are necessary in recording and prioritizing project risks. The following sections describe these phases for the project.

4.1 Risk Identification

The process of risk identification and analysis is a continuing effort that will become a routine practice in the GLAST Project management philosophy. Identification and reporting of project risks is responsibility of all GLAST Project personnel. Project activities such as programmatic and technical meetings, telecons, reviews, and other communication interchanges, will surface project risks. When this occurs, the risk (if not previously recorded) should be captured by placing it on a Risk Information Database to be analyzed and tracked.

The initial risk statement is captured in the Risk Description block of the Risk Information Sheet and will contain the risk condition; Consequence(s) + Context condition, one consequence, and context description. Performing this task provides the project the ability to transform uncertainties and issues into tangible and manageable risks. This also allows the project to locate and manage risks before they become problems.

As described above, risk identification is part of the ongoing project activities and not a separate discipline or group of activities. Risk identification is the responsibility of every individual involved in the Project. The overall objective of identifying and managing project risks is to reduce or eliminate risks before they become problems, thus resulting in increased chances of the project's success.

The GLAST Risk Management Board will meet on a regular basis. This will ensure that no identified risk in the database is overlooked, and that all active risks are being addressed.

Risks can be present in any area of the Project. Risks may be technical or programmatic. If risks are technical, they may be attributed to:

- inconsistent or incomplete requirements
- design oversights
- unproven technologies
- interface or integration difficulties
- unanticipated fault detection
- unforeseen quality and/or safety issues
- insufficient resources (e.g., mass power, data rate, computer capability)

These and other technical risks may be with the spacecraft, the instruments, the ground system or any other part of the mission. The technical risks generally involve technical disciplines such as systems engineering, hardware and/or software engineering, integration & test.

Programmatic risks include all risks that are not technical by nature. However, technical risks may include some attribute of a programmatic risk like impact to cost and/or schedule. Programmatic risks generally involve management resources, communications, and decisions.

A Risk List will be developed and maintained by the PRM, based upon information from the GLAST RM database. This risk list will be revised monthly (per NPG 8000.4).

4.2 Risk Analysis

Once a GLAST Project technical or programmatic risk has been identified and written as a risk statement (Condition; Consequence(s) + Context) in the Risk Information Database, it is then analyzed. The analysis of the risk statement considers three identifiers for prioritizing and establishing the importance of identified risks.

The prioritization process is performed as a roll-up function starting at the risk element identified by the individual person and weighted through the risk process up to the system level. An identified risk may receive a higher prioritization at the element level than it would when rolled-up to the system level. These three identifiers for risk weighting at the system level are:

- Consequence — the severity if risk should materialize
- Likelihood — the likelihood of risk occurrence
- Timeframe — time to start action or mitigation

CH-01

The above three identifiers are prioritized into five categories as follows:

Consequence (the severity if risk should materialize and no mitigating action is taken) CH-01

Very High (5)	Technical Impact Critical; Possible Loss of Spacecraft, one or more Instruments, or inability to meet Level 1 Science requirements Potential Project cost increase over baseline greater than $3M

	Cannot achieve a major program milestone
High (4)	Technical Impact High; Descope, or extensive workaround required. Potential Project cost increase over baseline of between $1M and $3M Level 2 milestone slip of greater than 1 month; or impact to critical path
Moderate (3)	Technical Impact Moderate; Modest adjustments to baseline flow are required Potential Project cost increase over baseline of $250K and $1M Level 2 milestone slip of less than 1 month.
Low (2)	Technical Impact Low; Baseline approach retained, with minor modifications to flow. Potential Project cost increase over baseline of $50K and $250K Additional activities (testing; etc) added to schedule flow to mitigate risk.
Very Low (1)	Technical Impact Very Low; Very modest adjustments to baseline flow are required Potential Project cost increase over baseline of less than $50K Very minimal impact to baseline schedule flow or durations.

Likelihood (the likelihood of risk occurrence) CH-01

- Very High (5) = Near Certainty 95% to 100%
- High (4) = Highly Likely 70% to 95%
- Moderate (3) = Likely 40% to 69%
- Low (2) = Not Likely 15% to 39%
- Very Low (1) = Very Un-Likely 01% to 14%

TIME (time to start action or mitigation)

- Near Term (N) = >3 months
- Mid Term (M) = 4 months to 9 months
- Far Term (F) = >10 months

The author/originator of the risk provides the risk "title" and "statement", dates it in the "identified" field, and places their name in the "submitter name" field on the GLAST Risk Information form. In addition she/he completes the "context" and "class" fields and send the form on to the Project Risk Manager (PRM). The PRM receives the Risk Information sheet, reviews it for completeness and brings it to the next scheduled GLAST Project review meeting as an agenda item to be reviewed for acceptance/rejection. At the staff review meeting the risk consequence, likelihood, and time frame will be determined for the individual risks and these values are placed on the Risk Information Database. CH-01

If accepted, the Risk Information Database is tracked by the PRM. The identified risk is also placed on the Risk Tracking Log for tracking purposes. Appendix B includes the Risk Information Database template and process/instructions for filling it out. Upon acceptance, a Risk Mitigation Manager will be assigned to the risk. She/He will be held accountable for developing a Risk Mitigation Plan, implementation of said plan; reporting status of the mitigation process; and proper closure of the risk.

4.3 Risk Planning

In this phase of the GLAST Project CRM process, the Project decides what action, if any, will be taken to manage/mitigate the risk or set of related risks. There are four actions that can be assigned to a risk. The options are:

- **RESEARCH** the risk to gain more information about it.
- **ACCEPT** the risk as stated and do nothing about it other than accept it.
- **WATCH** for identified "triggers" before taking any action about the risk.
- **MITIGATE** the risk to reduce or eliminate it.

Characterization of a Primary Risk as "***Acceptable***" are be supported on those the grounds, with the concurrence of the GPMC; that "all reasonable mitigation options (with-in cost, schedule, and technical constraints) have been exhausted.

5.0 Risk Tracking, Control, and Communication

Performing risk tracking, control, and communication for the Project is necessary to ensure risks are tracked and are not lost in the process. The following paragraphs describe these three phases of the CRM process.

5.1 Risk Tracking

In the risk tracking phase the Project acquires, compiles, and reports information on selected risks. This phase is necessary to collect accurate, timely, and relevant Project risk information and to present it in a clear manner. This information is be provided by the GLAST RM at monthly Project Status Review (PSR) meetings and be included on the agenda as required. This information is also be provided in project review reports along with other project status information. Those risks assigned/added to the "Watch List" will be reviewed along with active risks at regular intervals.

Individuals and groups identify/document risks. The Risk Lead tracks and reports on each risk to GLAST RMB. The Project Manager controls risks within the project, and provides status to upper management as required. Any risk that is of high priority and needs support beyond the project's capability will be brought to upper management's attention for their support and/or resolution.

Important GLAST Project technical and programmatic risks that are addressed by mitigation planning are be monitored and tracked by the PRM for reduction and/or closure of the risk. This process provides some method of measurement to show progress toward achieving the prescribed goal

Each identified project risk that is to be mitigated with a risk plan addresses how progress towards reduction or closure can be measured. It is good to note that only meaningful current data should be collected and measured for any given project risk.

5.2 Risk Control

During the controlling phase, informed, timely, and effective decisions are made regarding risks and their mitigation plans. Risk control is performed using standard GLAST Project Management monitoring techniques. Controlling risks will be integrated and coordinated in the project's routine management activities.

The following are mitigation plan decisions:

- Replan
- Close the risk
- Invoke a contingency plan

- Continue tracking and executing the current plan

The decisions to proceed on mitigation planning are essential and require current accurate data to effectively make the right decisions in the control phase. The Project Manager or designee will make final decisions on risk mitigation planning.

5.3 Risk Communication

Communicating risks on the project provides personnel an understanding of the project's overall status with regard to risks and mitigation alternatives. Successful risk communication raises the level of understanding of relevant issues or actions. CRM communications have the following characteristics:

- Free flow of information between individuals, groups, and the GLAST Project Organization
- Inclusion of formal, informal, and impromptu communications
- Value of individual contributions
- Application of consensus voting of teams

The Risk Information Database and Risk Tracking Log is be used, maintained, and controlled throughout the GLAST Project CRM process. This information will be available and reviewed by the project personnel on a periodic basis.

The Project has a Web Site to provide access to risk status information. Appendix B depicts an example of the CRM use in the GLAST Project WEB Site. The GLAST RM web site will contain security measures (password protection) sufficient to guard against the improper use of project sensitive material.

6.0 PRA; FTA; FMEA; Resources

6.1 Probabilistic Risk Assessment (PRA)

The reliability engineer using information provided by the project team, and integrated as part of the overall GLAST CRM process will coordinate PRA activity, including Fault Tree Analysis (FTA) and Failure Mode and Effect Analysis. The PRA will be used to identify weak links in the design, to evaluate the effects or consequences of failures, assist in trade-offs, and to evaluate possible mitigation approaches to eliminate or reduce risks.

The final outcome of the PRA is a relative ranking of technical "risk drivers" that will be performed and updated on an iterative basis throughout design and development. Results of the PRA will be provided to the GLAST Risk Management Review Board as a decision making tool for identification of risks and development of mitigation/contingency plans for controlling these risks.

6.2 Fault Tree Analysis (FTA)

FTA will be performed on the hardware and software as a "top down" approach to identify and assess risks, and apply the appropriate mitigation when possible. It is be iterated during design as new information is developed.

6.3 Failure Modes and Effect Analysis (FMEA)

A Failure Modes and Effects Analysis (FMEA) will be performed early in the design to identify system design issues from a "bottom-up" standpoint. As the design matures and changes, the FMEA will be revised. Failure modes will be assessed at the component level and their effects through the spacecraft and mission levels. Severity (criticality) levels will be assigned each failure mode. The FMEA will be used to help verify that all critical hardware and safety issues have been identified and addressed.

6.4 Resources

The GLAST project will commit resources sufficient to implement risk management in accordance with NASA/GSFC guidelines throughout the GLAST Mission life cycle. The GLAST Project will use management cost reserves to fund risk mitigation activities with-in scope (as it is currently defined). Implementation of project risk management began at the LAT Instrument PDR, and will continue through the completion of the mission life cycle.

7.0 Risk Tools and Implementation

This Section identifies the tools that will be used for CRM by the GLAST Project. The tools are utilized throughout the project for technical and programmatic risks. The tools are used by individuals, teams, and management to identify, analyze, plan, track, and control project risks. These tools are described in the CRM Guidebook. A copy is issued to each student when they take the CRM course. The following tools are specifically used by the project:

- **CRM Training** - The GLAST Project management and all Sub-System Managers have participated in a formal training session on CRM provided through the GSFC Office of Human Resources. Class material provided the CRM methods and tools needed and identified in this plan. CRM training is required by of all Project personnel. New employees will attend a class.

- **Risk Management Plan** - This documents how CRM will be implemented for the GLAST Project. This plan will be maintained by the PRM, reviewed at least annually, and updated as required. It is the PRM's responsibility with the Project Manager's support to ensure that this plan is implemented.

- **Risk Information Database** - (see Appendix B, Figure B-2) The initial means of identifying and documenting a risk. The form is maintained throughout the life of an identified risk, and information is added to the form when known and available. Appendix B includes the form template and process/instructions for filling the form out. Completed forms will be maintained by the PRM in a database system under Configuration Management (CM).

- **Risk Tracking List** - This list provides a risk number, title, and quick look-up for all identified and accepted project risks. The list identifies a responsible person and due date for the risk that serves as a tickler file until risks are closed. The PRM, with clerical support, is responsible for updating, maintaining, and disseminating this list.

- **GLAST Project Risk Management Process Diagram -** (see Figure 3-1) The diagram depicts the project's risk management flow process. It is meant to portray that CRM is an overlay of ongoing activities and not a separate activity. It also portrays that the CRM Plan plays a major role in describing the GLAST Project CRM process.

- **Project Metrics** There are various types of metrics supporting both technical and programmatic activities. GLAST Project uses metrics in estimating and showing progress within the project. This effort will continue and will be used in risk management for risk monitoring, tracking, forecasting, and reporting.

- **GLAST Project WEB Site** – GLAST Project WEB Site will incorporate the Risk Information Sheet for individual use and forwarding. The WEB Site will also include the Risk Action Item List for providing status of the projects risks. A WEB Site CRM example is included in Appendix B.

- **Mitigation Plans -** These plans will be developed for a risk or set of risks (similar within the same family/closely related) that require significant resources to reduce or close the risk(s). Information required for a mitigation plan (technical and/or programmatic) includes:

  - Title and serial number of the project risk(s) as is on the Risk Information Database

  - Description of how the risk(s) will be mitigated and measurement used to indicate progress. Provide method and frequency of reporting progress and status

  - Schedule and resources (hours, dollars, etc.) needed to implement the mitigation plan. Show the individual responsible for the activity and Project Manager approval to implement the mitigation plan.

- **Project Formal/Informal Meetings** - All project formal and informal meetings should have CRM as a topic on the agenda when it is appropriate. These meetings are the means of providing the most effective communications to the project on CRM. Several tools are available to be used within meetings. They range from simple Brainstorming, Multi-voting and Voluntary Risk Reporting to more formal Stoplight Charts, Bar Graphs, etc.

7.1 Risk Classification Methodology:

The GLAST Risk Management System uses a project defined algorithm to determine the risk Likelihood and Consequence values. These values are combined to produce a "Cumulative Risk Value" This CRV is used by the project to determine risk severity and prioritize risks within the system. Using the five-by-five matrix cube, with a total of twenty-five possible points on the score card we have weighted the probability with sixty percent of the total (15 points) and the impact with forty percent (10 points). The consequence value is a derivative of the technical (40%), cost (30%), and schedule (30%) assessment (see Fig. B-3). The threshold for these values is defined on the GLAST Risk Summary Score Card. (Fig. B-2). CH-01 CH-01

Once the Consequence and Likelihood values have been determined, they are plotted on the five-by–five matrix. The Likelihood value is plotted along the Y-Axis, and the Consequence value CH-01

along the X-Axis. Where these two points intersect, defines the placement on the five-by-five matrix for reporting.

7.2 Risk Classification Hierarchy for NASA Payloads:

In accordance with NASA Procedural Requirement (NPR) 8705.4, Risk Classification for NASA Payloads, dated June 14, 2004, the GLAST Payload meets the criteria for **Class B Risk Classification Level under NPR 8705.4 Appendix A.** CH-02

The following Appendix A is from NPR 8705.4:

Appendix A – Classification Considerations for NASA Class A-D Payloads

Four risk levels or classifications have been characterized in Appendix A. The classification considerations in this appendix provide a structured approach for defining a hierarchy of risk combinations for NASA payloads by considering such factors as criticality to the Agency Strategic Plan, national significance, availability of alternative research opportunities or reflight opportunities, success criteria, magnitude of investment, and other relevant factors. Additional or alternate classification considerations may be applied to a specific payload or payload element. The importance weighting assigned to each consideration is at the discretion of the responsible NASA Enterprise office.

~~Characterization~~	Class A	Class B	Class C	Class D
Priority (Criticality to Agency Strategic Plan) and Acceptable Risk Level	High priority, very low (minimized) risk	High priority, low risk	Medium priority, medium risk	Low priority, high risk
National significance	Very high	High	Medium	Low to medium
Complexity	Very high to high	High to medium	Medium to low	Medium to low
Mission Lifetime (Primary Baseline Mission)	Long, >5years	Medium, 2-5 years	Short, <2 years	Short < 2 years
Cost	High	High to medium	Medium to low	Low
Launch Constraints	Critical	Medium	Few	Few to none
In-Flight Maintenance	N/A	Not feasible or difficult	May be feasible	May be feasible and planned
Alternative Research Opportunities or Re-flight Opportunities	No alternative or re-flight opportunities	Few or no alternative or re-flight opportunities	Some or few alternative or re-flight opportunities	Significant alternative or re-flight opportunities
Achievement of Mission Success Criteria	All practical measures are taken to achieve minimum risk to	Stringent assurance standards with only minor compromises in application to	Medium risk of not achieving mission success may be acceptable.	Medium or significant risk of not achieving mission success is

	mission success. The highest assurance standards are used.	maintain a low risk to mission success.	Reduced assurance standards are permitted.	permitted. Minimal assurance standards are permitted.
Examples	HST, Cassini, JIMO	MER, MRO, Discovery payloads, ISS Facility Class Payloads, Attached ISS payloads	ESSP, Explorer Payloads (MIDEX, SMEX), ISS complex subrack payloads	SPARTAN, GAS Can, technology demonstrators, simple ISS, express middeck and subrack payloads

NOTES:

1. Mission impact; i.e., loss of function effect on other payloads or ISS operations may also be a characterization factor. For example, loss of the function of freezers and centrifuges may impact other payloads and increase the overall level of risk.

2. The safety risk to crew inherent in the operation of a human-crewed vehicle may be a factor in payload classification determinations. Class C and D payloads that have a medium or high risk of not achieving mission success may be considered unsuitable for launch on a crewed vehicle, unless they are secondary payloads making use of available launch capacity that would otherwise go unused.

3. Other situation-dependent payload classification considerations may include human-rating environment, logistics support, and interoperability interfaces.

Appendix A. GLAST Project Acronym List

AGN	-	Active Galactic Nuclei
AO	-	Announcement of Opportunity
ACS	-	Attitude Control System
AOS	-	Advanced Orbiting Systems
ATD	-	Advanced Technology Development
BER	-	Bit Error Rate
bps	-	Bits per second
CCSDS	-	Consultative Committee for Space Data Systems
CDR	-	Critical Design Review
CGRO	-	Compton Gamma Ray Observatory
CIL	-	Critical Items List
CM	-	Configuration Management
CRM	-	Continuous Risk Management
CSOC	-	Consolidated Space Operations Contract
CY	-	Calendar Year
DB	-	Data Base
DOE	-	Department of Energy
DOORS	-	Dynamic Object Oriented Requirements System
E	-	Energy
EEE	-	Electrical, Electronic, and Electromechanical
EGRET	-	Energetic Gamma Ray Experiment Telescope

FMEA	-	Failure Modes and Effects Analysis
FOV	-	Field of View
FTA	-	Fault Tree Analysis
FY	-	Fiscal Year
GBM	-	GLAST Burst Monitor
Gbps	-	Gigabits per second
GCN	-	Gamma-ray Burst Coordinate Network
GeV	-	Giga Electron Volts
GIOC	-	GBM Instrument Operations Center
GLAST	-	Gamma-ray Large Area Space Telescope
GO	-	Guest Observer
GN	-	Ground Network
GNC	-	Guidance, Navigational and Control
GPS	-	Global Positioning System
GRAPWG	-	Gamma-Ray Astronomy Program Working Group
GRB	-	Gamma-ray Burst
HEASARC	-	High Energy Astrophysics Science Archive Research Center
ICD	-	Interface Control Document
IDS	-	Interdisciplinary Scientist
IMDC	-	Integrated Mission Design Center
IOC	-	Instrument Operations Center
IRD	-	Interface Requirements Document
IRF	-	Instrument Response Function

IV&V	-	Independent Verification and Validation
JOG	-	Joint Operating Group
Kbps	-	Kilobits per second
kg	-	Kilogram
LAT	-	Large Area Telescope
LIOC	-	LAT Instrument Operations Center
LOF	-	LAT Operations Facility
LV	-	Launch Vehicle
MA	-	Multiple Access
MAG	-	Mission Assurance Guidelines
MAR	-	Mission Assurance Requirements
MeV	-	Mega Electron Volts
MOC	-	Mission Operations Center
MOU	-	Memorandum of Understanding
Mbps	-	Megabits per second
MSPSP	-	Missile System Prelaunch Safety Package
MSS	-	Mission System Specification
NAS	-	National Academy of Sciences
NISN	-	NASA Integrated Services Network
NRL	-	Naval Research Laboratory
PAF	-	Payload Attach Fitting
PAIP	-	Product/Performance Assurance Implementation Plan
PDR	-	Preliminary Design Review

PI	-	Principal Investigator
PMT	-	Photo-Multiplier Tubes
PRA	-	Probabilistic Risk Analysis
PSF	-	Point Spread Function
PWB	-	Printed Wiring Board
RFI	-	Request for Information
RSDO	-	Rapid Spacecraft Development Office
RMB	-	Risk Management Board
SAA	-	South Atlantic Anomaly
SAGENAP	-	Scientific Assessment Group for Experiments on Non-Accelerator Physics
S&MA	-	Safety and Mission Assurance
SAS	-	Science Analysis Software
SC	-	Spacecraft
SEU	-	Structure and Evolution of the Universe or Single Even Upset
SGL	-	Space Ground Link
SI	-	Science Instrument
SLAC	-	Stanford Linear Accelerator Center
SN	-	Space Network
SR&T	-	Sustaining Research & Technology
SSC	-	Science Support Center
SR	-	Steradian
SRD	-	Science Requirements Document
SRR	-	System Requirements Review

SRO	-	Systems Review Office
SSR	-	Solid State Recorder
SWG	-	Science Working Group
TBD	-	To Be Determined
TBR	-	To Be Resolved
TDRSS	-	Tracking & Data Relay Satellite System
TOO	-	Targets of Opportunity
VCDU	-	Virtual channel Data Unit
VR	-	Validation Reviews
W	-	Watts
WAN	-	Wide Area Network

Appendix B. Document Figures and Process/Completing On-Line Risk Information Database Form

The GLAST Risk Management Web Site is located on the World Wide Web. A key to data entry for is located in figures B-1. The guidelines listed below are also available on-line by mouse-clicking on the field heading. For technical assistance, please forward your inquiries to rgarnett@pop400.gsfc.nasa.gov.

GLAST Risk Management Database

(Data Entry Form Guidelines)

Field # 01 (**Risk ID**): An automated, system generated ID number. No data required.

Field # 02 (**Risk Name**): Provide a one phrase title for the risk. Be sure to state the risk as a potential problem.

Field # 03 (**Risk Priority**): A numerical score derived from data provided by the originator in items # 10; 14;22;23; and 24. The basis for this score is a weighted algorithm using given inputs. The meaning of the priority is shown on the Risk Summary ScoreCard (figure B-2). The color of this field corresponds to the legend in the Risk Summary ScoreCard.

Field # 04 (**Open Date**): Date risk item is reported. This is automatically generated by the system.

Field # 05 (**Originator**): Name of risk reporter.

Field # 06 (**Risk Description**): Describe and characterize in detail, the nature of the risk. Do not include the impact of realizing this risk in this field.

Field # 07 (**Risk Mitigation**): Summarize a high level approach to be taken which should eliminate, avert, or reduce the risk to an acceptable level.

Field # 08 (**Risk Impact Assessment**): Describe the negative technical; cost; and or schedule

consequence of the risk., **assuming no mitigation steps are taken**.

Field # 09 (**Cumulative Risk Impact**): Calculated composite risk value, based upon the values input from fields 22; 23; and 24.

Field # 10 (**Risk Probability**): Estimate the likelihood of the risk occurring. **Assuming prescribed mitigation steps are taken**. Use definitions found on the Risk Summary Score Card. Select one value only.

Field # 11 (**Decision Milestone**): Date when decision to begin risk mitigation plan described in Field # 7 must be started, in order to be effective.

Field # 12 (**Risk Mitigation Implementation Plan**): Describe in detail the steps to be taken (including responsible personnel), in order to carry out the risk mitigation approach summarized in Field # 7.

Field # 13 (**Risk Type**): Define the type of risk, and the program utility(s) affected. (You may select more than one.)

Field # 14 (**Risk Period**): Define the timeframe when the risk would become a problem, if no corrective action were taken.

Field # 15 (**Current Status**): Provide the current status of the risk, including progress made in carrying out the defined Risk Mitigation Implementation Plan.

Field # 16 (**Affected Systems**): Check all project areas which would be affected by this risk. You may select more than one.

Field # 17 (**Risk Mitigation Manager**): Indicate the person responsible for implementing the risk mitigation plan. This is not necessarily the same person who originates and reports status on the risk.

Field # 18 (**Date Risk Retired**): The Mission Manager will enter a date in this field when the

risk is deemed to be retired.

Field # 19 (**Risk Retired?**): Enter NO, upon originating a risk report. The Mission Manager change this field to YES, when defined appropriate.

Field # 20 (**Summary of Risk Resolution**): Mission Manager to supply narrative describing resolution to risk, once retired.

Field # 21 (**Status Date**): This field will be automatically updated each time the risk record is modified.

Field # 22 (**Technical Impact Assessment**): Assign a value based upon the GLAST Risk Summary Score Card (figure B-2) definition. Select one value only.

Field # 23 (**Cost Impact Assessment**): Assign a value based upon the GLAST Risk Summary Score Card (figure B-2) definition. Select one value only.

Field # 24 (**Schedule Impact Assessment**): Assign a value based upon the GLAST Risk Summary Score Card (figure B-2) definition. Select one value only.

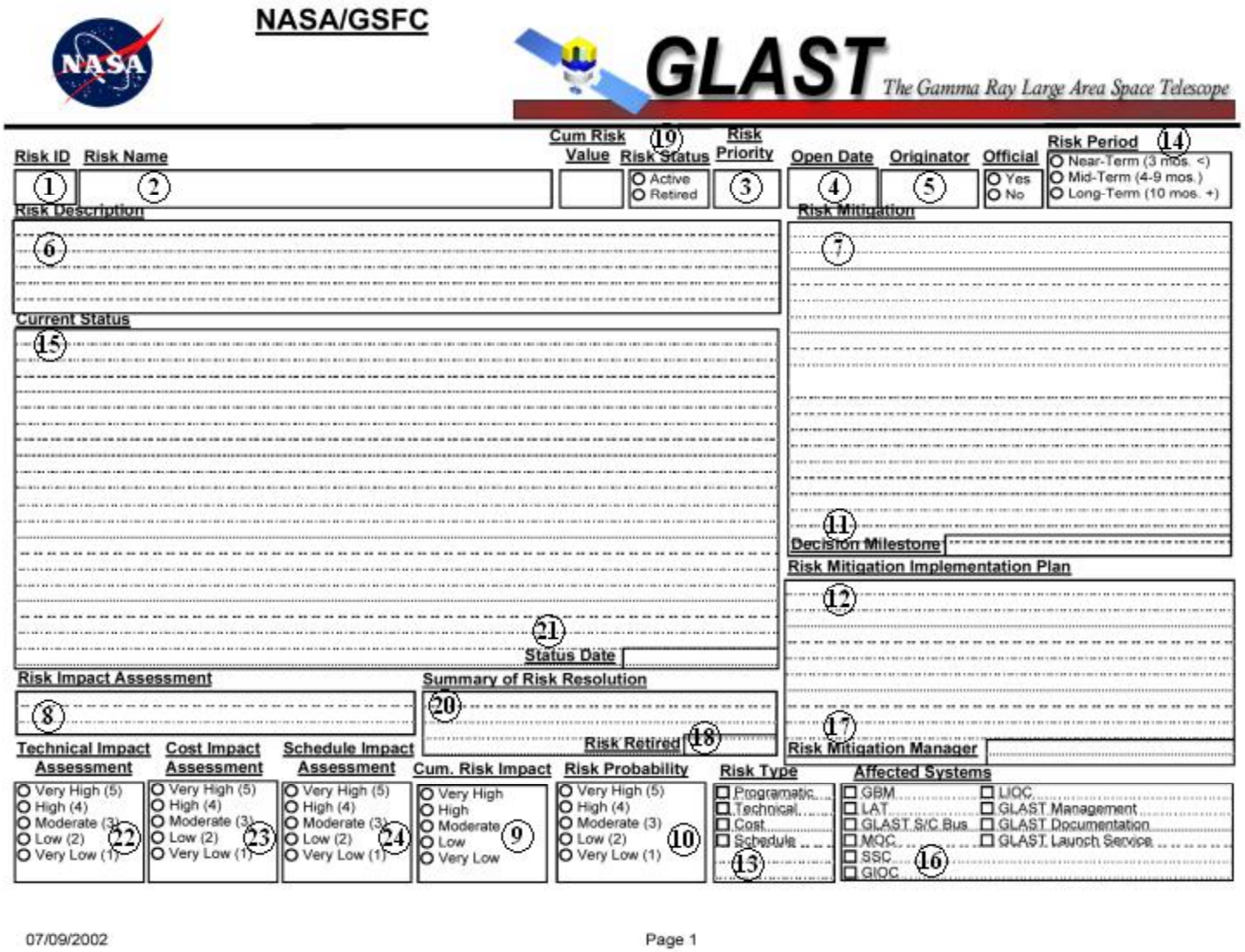


Figure B-1 Risk Information Sheet

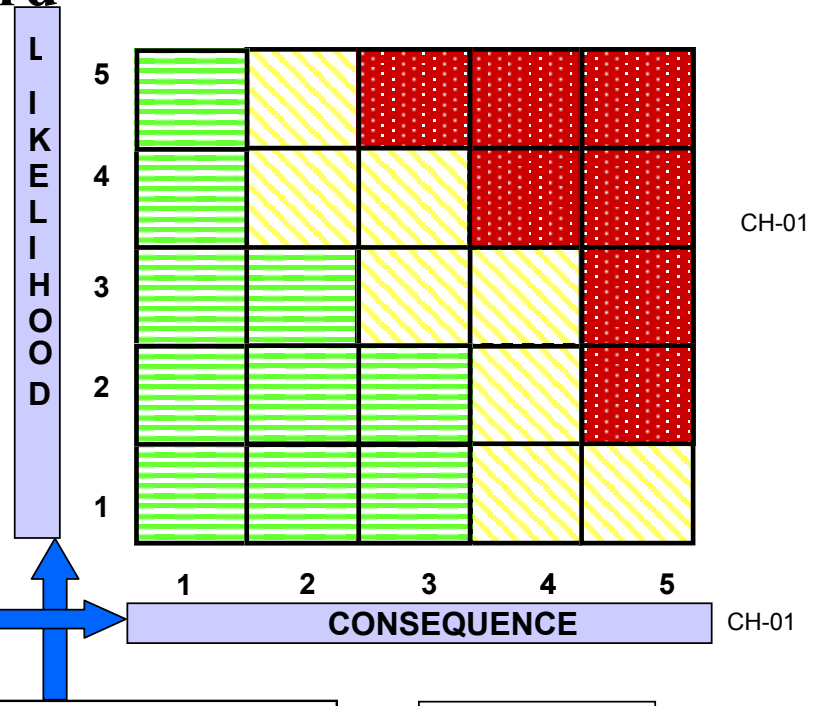
GLAST RISK SUMMARY
Score Card

DEFINITIONS:

RISK MANAGEMENT: An organized, systematic decision-making process that efficiently reduces or eliminates risks to achieving program goals.

RISK: A Program "Risk" is any circumstance or situation that poses a threat to: crew or vehicle safety, Program controlled cost; Program controlled schedule or major mission objectives, and for which an acceptable resolution is deemed unlikely without a focused management effort.

What is the Probability of the situation or circumstances will happen?		
Level	**Probability**	**The current process**
5	Very High	Cannot prevent this event, no alternate approaches or process are available
4	High	Cannot prevent this event, but a different approach or process might
3	Moderate	May prevent this event, but additional actions will be required
2	Low	Is usually sufficient to prevent this type of event
1	Very Low	Is likely sufficient to prevent this event



Given the event occurs, what is the magnitude of the Impact to the mission					
Level	**Very Low (1)**	**Low (2)**	**Moderate (3)**	**High (4)**	**Very High (5)**
Technical	Minimal or no Impact	Moderate reduction, same approach retained	Moderate reduction, workarounds required	Major reduction, workarounds required	Unacceptable, no alternates exist
Schedule	Minimal Impact	Additional activities required in order to meet need date	Level 2 Milestone slip of up to <= 1 month	Lvl 2 Milestone slip of > 1 mth, or critical path impacted	Cannot achieve major program milestone
Cost	Minimal Impact of <$50k	Budget increase between $50k and $250k	Budget increase between $250k and $1M	Budget increase between $1M and $3M	Budget increase greater than $3M

LEGEND

High - Implement new process(es) or changes baseline plan(s)

Med - Aggressively manage; consider alternative process

Low - Monitor

Figure B-2 Risk Score Card

GLAST RISK MANAGEMENT
(Algorithm Sample Worksheet)

CONSEQUENCE SCORES						
	40%	1.2	**30%**	0.6	**30%**	1.5
	Technical	**3**	**Schedule**	**2**	**Cost**	**5**
Very Low	1	0.4	1	0.3	1	0.3
Low	2	0.8	2	0.6	2	0.6
Moderate	3	1.2	3	0.9	3	0.9
High	4	1.6	4	1.2	4	1.2
Very High	5	2	5	1.5	5	1.5

CH-01

Weighting	Axis	Raw Score	Weighting Factor	Weighted score
40.00%	Impact	**3.30**	2	6.6
60.00%	Probability	**4.00**	3	12

18.600 - Numerical Score

Moderate - Risk Management Ranking

Impact						
	5	**13**	**16**	**19**	**22**	**25**
	4	**11**	**14**	**17**	**20**	**23**
	3	**9**	**12**	**15**	**18**	**21**
	2	**7**	**10**	**13**	**16**	**19**
	1	**5**	**8**	**11**	**14**	**17**
		1	**2**	**3**	**4**	**5**
			Probability			

Figure B-3 GLAST Risk Algorithm Sample Worksheet